ANL_HEP_WF Note 196
April 12, 2000

The Longitudinal and Transverse Wake-fields in a thin dielectric disk structure

Wei Gai, X. Sun and P. Zou
High Energy Physics Division
Argonne National Laboratory
Argonne, IL 60439

1. Introduction

Lately there were questions raised about the wakefield generation when a single bunched e-beam passing a dielectric disk with a small hole in the center. It is important to understand this problem because it has certain implication on the on going E157 experiment at SLAC [1]. In this note we give our calculated results of the longitudinal and transverse wake-fields in a cylinder symmetry dielectric loaded structure by using MAFIA[2]..

2. Wake-fields problem set up in a Dielectric Disk Structure

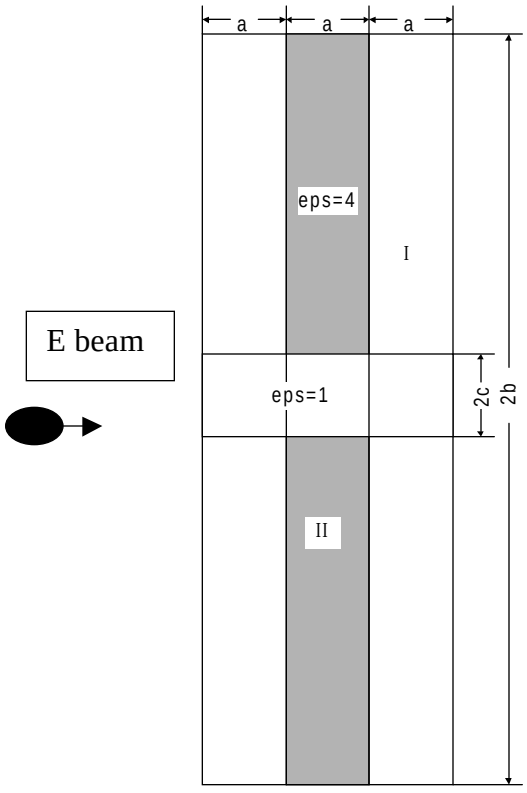


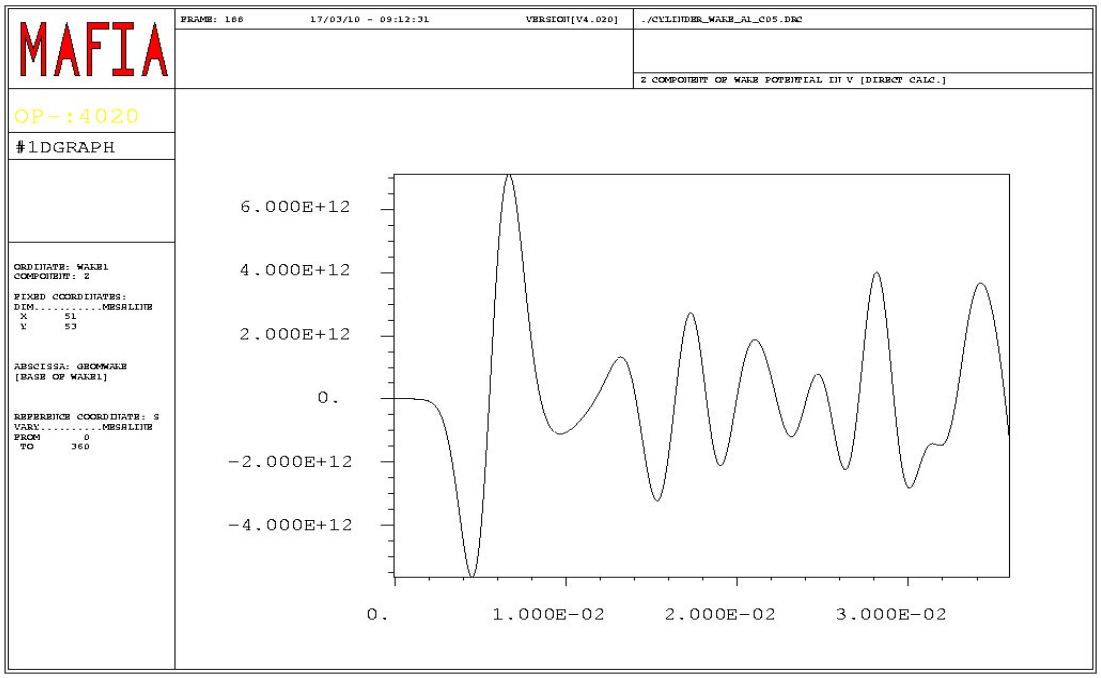
Fig. 1. Dielectric loaded structure used for simulation. a = 1 mm, b = 0.5 mm, c = 0.5 mm. Region I: vacuum, II: dielectric.

This structure is a metallic tube with inner radius $b = 4.5\ mm$ and length $3a = 3\ mm$, partially filled with isotropic material with dielectric constant $\varepsilon = 4$ and length $a = 1\ mm$, containing a hole of radius $c = 0.5\ mm$ at the center, shown as Fig. 1. On the both side of the dielectrics, we choose waveguide boundary condition to simulation the real world.

We use the MAFIA code to perform a full (3D) time domain electromagnetic simulation of the structure with the parameters described above.

The beam parameters are: rms electron bunch length is $1\ mm$ and the charge is $1\ C$ (default). We purposely beam was purposely steered off center for $r_0 = 0.25\ mm$.

The longitudinal and transverse wake fields have been calculated, shown as Fig. 2 and 3 separately.



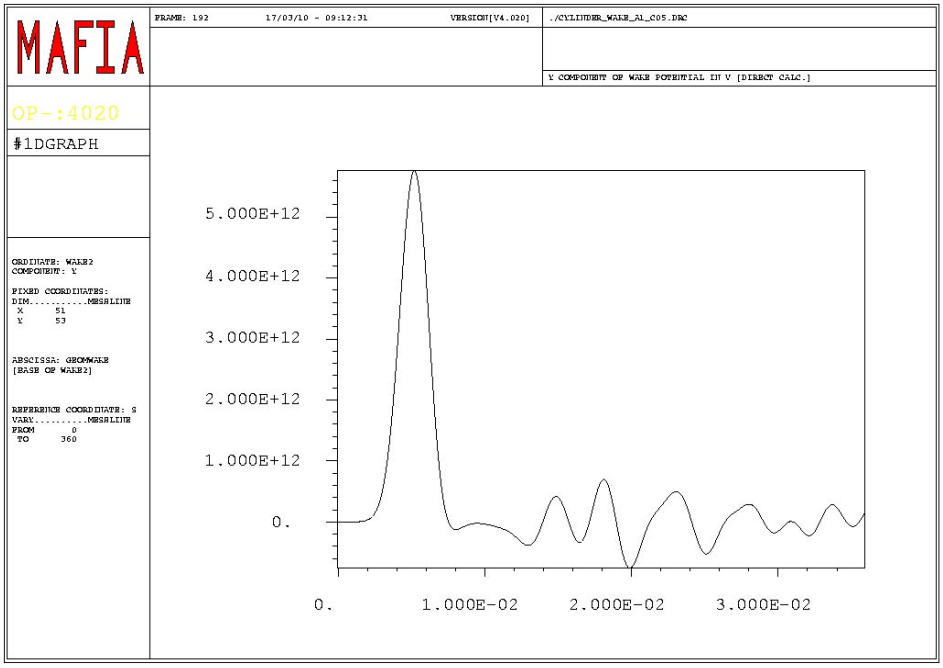


Fig. 3. Calculated transverse wake field at $r = 0.25$ *mm* by using MAFIA. The units of X and Y coordinate are meter and voltage separately.

We have also estimated several additional cases. By changing the length a, with the other parameters remain at the same time, the results are shown in Table 1.

Table1. Calculated wake fields for different thickness length a as $b = 4.5$ *mm*, $\varepsilon = 4$, $c = 0.5$ *mm*. The rms electron bunch length $\sigma = 1$ *mm* and the charge is *1 nC*.

a(mm)	Max longitudinal wake field (V)	Min longitudinal wake field (V)	Transverse wake field (V)
1	7.1×10^3	-5.6×10^3	5.7×10^3
2	1.4×10^4	-1.5×10^4	1.4×10^4
4	1.6×10^4	-2.7×10^4	1.5×10^4

3. Conclusion

The calculated results shown that both longitudinal and transverse wakefield generated by a beam passing a thin dielectric disk is tolerable for E157 experiment. The maximum wakefield would be ~1 MeV/8 nC for both L and transverse field.

Reference

[1] Chris Clayton, UCLA, private communications.
[2] MAFIA Version 4.0, Gesellschaft fur Computer-Simulationtechnik, Lauteschlagerstrabe 38, D-64289, Darmstadt, Germany.